DOCUMENT RESUME

ED 343 808 SE 052 808

AUTHOR Webb, Norman L.; And Others
TITLE Los Angeles Urban Mathematics/Science/Technology Collaborative Five-Year Site Report. Program Report 91-5 LA.
INSTITUTION Wisconsin Center for Education Research, Madison.
SPONS AGENCY Ford Foundation, New York, N.Y.
PUB DATE Dec 91
NOTE 42p.; For related documents, see ED 333 088-089, and SE 052 799-811.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS College School Cooperation; *Cooperative Programs; Educational Cooperation; *Faculty Development; Higher Education; Inservice Teacher Education; Intermediate Grades; Mathematics Education; Mathematics Instruction; *Mathematics Teachers; Secondary Education; *Social Networks; *Teacher Role; Teacher Workshops; *Urban Education
IDENTIFIERS California (Los Angeles County); *Collaboratives; Urban Mathematics Collaborative Project

ABSTRACT

The Urban Mathematics Collaborative (UMC) project has the goal of contributing to the improvement of mathematics education in the inner-city schools by identifying models to enhance the professional lives of teachers and encouraging the entry of high school mathematics teachers into a larger mathematics community including mathematicians from higher education and industry. This document is a 5-year site report on the Los Angeles Urban Mathematics/Science/Technology Collaborative from its inception in 1985 through June 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in the collaborative operated, the collaborative's management structure, and the focus of its activities. This final site report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as the goals of the total UMC project. (MDH)

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LOS ANGELES URBAN MATHEMATICS/ SCIENCE/TECHNOLOGY COLLABORATIVE

FIVE-YEAR SITE REPORT

A Final Report to the Ford Foundation on the Urban Mathematics Collaborative (UMC) Project

Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg, Allan J. Pitman, Edel M. Reilly, and James A. Middleton

Wisconsin Center for Education Research
School of Education, University of Wisconsin–Madison

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Report from the
Urban Mathematics Collaborative Documentation Project

Wisconsin Center for Education Research
School of Education
University of Wisconsin
Madison, Wisconsin

December 1991

We gratefully acknowledge the assistance of Margaret Powell, Kay Schultz, and Jeanne Connors in the preparation of this report.

The research reported in this paper was supported by the Ford Foundation and by the Wisconsin Center for Education Research, School of Education, University of Wisconsin-Madison. The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Ford Foundation or the Wisconsin Center for Education Research.

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I. INTRODUCTION

This document is a five-year Site Report on the Los Angeles Urban Mathematics/Science/Technology Collaborative Project +PLUS+ from its inception in 1985 through June, 1990. The intent is to reflect on the development of the collaborative, noting the changes that have taken place in regard to the context in which the collaborative operated, the collaborative's management structure, and the focus of its activities. It is not the intent of this report to review the development of the collaborative; this has been done in the annual reports. This final Site Report addresses the major influences exerted on the collaborative and the directions the collaborative has taken. Some conclusions are reached regarding both the collaborative's development and achievements in light of its specific goals as well as those of the total Urban Mathematics Collaborative project.

The Urban Mathematics Collaborative Project

In 1984, the Ford Foundation initiated the Urban Mathematics Collaborative (UMC) project to improve mathematics education in inner city schools and to identify new models for meeting the on-going professional needs of urban teachers. In February, 1985, the Foundation awarded five grants to establish urban mathematics collaboratives in Cleveland, Minneapolis-St. Paul, Los Angeles, Philadelphia, and San Francisco. In addition, the Ford Foundation established a Documentation Project at the University of Wisconsin-Madison to chronicle the development of the new collaboratives and a Technical Assistance Project (TAP) at the Education Development Center (EDC) in Newton, Massachusetts, to serve as a source of information for the collaborative projects (Romberg & Pitman, 1985). During the next 18 months, UMC projects were funded in Durham, Pittsburgh, San Diego, St. Louis, Memphis, and New Orleans, for a total of eleven collaboratives (Webb, Pittelman, Romberg, Pitman, Fadell, & Middleton, 1989). In August, 1987, an Outreach Project was funded at EDC to publicize and expand the UMC effort. In August of 1989, the Ford Foundation awarded replication grants to three additional sites: Dayton, Ohio; Columbus, Georgia; and Milwaukee, Wisconsin. In April, 1991, the fifteenth and final collaborative, the Greater Worcester Urban Mathematics Collaborative, was established in Massachusetts. A map indicating the location of UMC projects is presented in Figure 1.

The
Urban Mathematics Collaborative Project

Funded by The Ford Foundation

- **Cleveland Collaborative for Mathematics Education (C^2ME)**
  Cleveland, Ohio
- **Durham Collaborative: The Durham Mathematics Council**
  Durham, North Carolina
- **Los Angeles Urban Mathematics/Science/Technology Collaborative (LAUM/S/TC)**
  Los Angeles, California
- **Memphis Urban Mathematics Collaborative**
  Memphis, Tennessee
- **New Orleans Mathematics Collaborative (NOMC)**
  New Orleans, Louisiana
- **Philadelphia Math Science Collaborative**
  Philadelphia, Pennsylvania
- **Pittsburgh Mathematics Collaborative**
  Pittsburg, Pennsylvania
- **St. Louis Urban Mathematics Collaborative**
  St. Louis, Missouri
- **San Diego Urban Mathematics Collaborative**
  San Diego, California
- **San Francisco Mathematics Collaborative**
  San Francisco, California
- **Twin Cities Urban Mathematics Collaborative**
  Minneapolis-St. Paul, Minnesota

Replication Sites

- **Columbus Regional Mathematics Collaborative (CRMC)**
  Columbus, Georgia
- **Dayton-Montgomery County Public Education Fund Mathematics Collaborative**
  Dayton, Ohio
- **Greater Worcester Urban Mathematics Collaborative**
  Worcester, Massachusetts
- **Milwaukee Metropolitan Mathematics Collaborative (M^3C)**
  Milwaukee, Wisconsin

Figure 1. The National Network of Urban Mathematics Collaboratives.

During the five years covered in this Site Report, mathematics education in the United States has changed. When the Ford Foundation initiated the UMC project in 1984, a consolidated effort to reform mathematics had not yet begun, although the potential of the mathematics education community for achieving reform was envisioned. In this regard, the UMC project was innovative in mobilizing a group of inner city teachers to increase both their sense of professionalism and their connections with mathematicians in the business community and in higher education. Between 1985 and 1990, the landscape of mathematics education in this country began to change dramatically. In an effort to develop a new mandate based on such studies as *Renewing United States Mathematics: Critical Resource for the Future* (Commission on Physical Sciences, Mathematics, and Resources, 1984) and *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education, 1983), the Mathematical Sciences Education Board in 1989 issued *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* and the National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics*. As the collaboratives matured, the movement to change mathematics education in the country took on momentum, creating a new environment for the collaborative network. What began as a project designed to enhance the professional development of urban teachers evolved into a catalyst for the reform of mathematics education.

At each site, the UMC project supports collaboration among school mathematics teachers and between teachers and mathematicians from institutions of higher education and industry; it also encourages teacher membership and participation in a broad-based local mathematics community. Although the guiding principle behind the UMC effort has been that the teacher is and will remain at the hub of the educational process, it has become evident that many teachers--and especially those in inner-city schools--are overworked; lack support and material resources; and are isolated from their colleagues, from other professionals, and from the rapidly changing field of mathematics. Thus, the focus of the UMC project remains rooted in the premise that collegiality among professional mathematicians can reduce teachers' sense of isolation, enhance their professional enthusiasm, expose them to a vast array of new developments and trends in mathematics, and encourage innovation in classroom teaching.

Structure of the Five-Year Summary

The Five-Year Summary presented in the following chapter is comprised of six sections. The first section provides a brief overview of the collaborative. In the second section, the purpose of the collaborative is presented, as stated in its proposals to the Ford Foundation. The goals outlined in the collaborative's final request for funds to the Ford Foundation are contrasted with those specified in its initial proposal. The third section discusses the context within which the collaborative operated and the extent to which this has remained stable or has changed over the five-year period. Topics addressed in this section include demographic information on the surrounding community, changes in school district administration and enrollment and in the teacher population targeted by the collaborative, and significant changes occurring in mathematics and in the professional environment. The fourth section of the report describes the management structure adopted by the collaborative and changes that occurred in that structure over the five-year period. The fifth section covers the collaborative's activities in relation to four major themes that emerged as dominant in most collaboratives during the document process: socialization and networking, increased knowledge of mathematics content, teacher professionalism, and teacher leadership. These themes are used as a focus to organize ideas and to reflect on the collaborative's development with respect to some overriding expectations of the UMC project. The sixth and final section presents the reflections of Documentation Project staff on the approach the collaborative took to achieve its goals and the perceived outcomes in the areas of collaboration, professionalism, and mathematics focus.

The information presented in the Site Report is both a condensation and synthesis of information collected over the span of the UMC Documentation Project. Data were collected through monthly reports, the electronic network, four large-scale surveys, two demographic surveys, site visits, and case studies. These data-collection instruments and procedures are described in detail in the *UMC Guide to Documentation* (Pittelman, Webb, Fadell, Romberg, Pitman, & Sapienza, 1991). Detailed information about the Urban Mathematics Collaborative project is presented in six annual reports, four technical reports, and a set of case studies prepared by the Documentation Project. All of these reports are listed in the References. The Site Reports, which offer a retrospective summary of each collaborative's efforts over the grant period, have not been reviewed by

collaborative personnel and thus present the reflections solely of Documentation Project staff.

II. FIVE-YEAR SUMMARY: 1985 TO 1990

A. Overview

The Professional Links with Urban Schools (+PLUS+), a program of the Los Angeles Educational Partnership (LAEP) since 1985, has worked towards broadening teachers' mathematical horizons by encouraging them to interact with their colleagues in a mathematics resource network and helping them to relate the mathematics curriculum to the world of work. +PLUS+ has successfully developed a multi-component program that has positively affected the professional lives of mathematics teachers in the Los Angeles area. Through +PLUS+, teachers have increased their knowledge of mathematics, their use of technology in teaching mathematics, and their interaction with each other. They have modified existing courses and implemented plans for solving the problems of student access to mathematics, student motivation, and student achievement. +PLUS+ has developed a core of teachers who are now assuming leadership roles in conducting workshops, training mathematics department teams, and managing satellite Teacher Councils. From 1985 to 1991, +PLUS+ activities attracted over 600 teachers representing more than 80 schools.

Each year, +PLUS+ has conducted a series of workshops for teachers in the Los Angeles area. This strategy was adopted to reach a large number of middle and secondary school teachers and to inform them of the current recommendations for the teaching of mathematics. The state's *Mathematics Framework for California Public Schools: Kindergarten through Grade Twelve* and the NCTM *Curriculum and Evaluation Standards for School Mathematics* guided the development of the workshops. From its beginning, +PLUS+ has attempted to develop teacher leadership and team building. Important components of +PLUS+ have been leadership training and departmental planning. Teachers have been encouraged to assume leadership roles in planning and presenting workshops. By the end of the 1989-90 school year, the departmental planning process, which is now facilitated by teachers involved mathematics departments from 29 schools. The Action Plans that each department generated have resulted in important changes.

B. Purpose

The stated purpose of +PLUS+ has changed in scope, but the essential elements and the spirit have remained the same since the collaborative began. The primary target audience of +PLUS+ consisted of high school mathematics teachers from the Los Angeles Unified School District and some other surrounding districts. After the first two years, middle school teachers began attending the +PLUS+ workshops, thereby extending the collaborative's influence to teachers in the middle grades.

When it was originally established, the collaborative had four purposes:

1. To provide for ongoing networking and collaboration among teachers, mathematics departments, and the diverse mathematics resources within the community;
2. To broaden the scope of teachers' knowledge through association with mathematics-related industries and institutions;
3. To explore the real-world relevance of mathematics for students in order to increase their interest in mathematics and mathematics-related careers; and
4. To promote team building and leadership skills for teachers.

In 1986-87, these purposes were expanded to acknowledge the importance of networking at the state and national levels; to provide teachers the opportunity to develop, evaluate, and integrate new materials and methods into the curriculum; and to place a greater emphasis on team building and developing leadership skills. With these refinements, the direction of +PLUS+ remained consistently focused on networking, broadening teachers' knowledge, increasing student interest in mathematics, and team building.

The advisory committee formed by LAEP to oversee the development of its mathematics, science, and technology programs, which included +PLUS+, was reconstituted during the course of the collaborative's development and reflected a change in LAEP's thinking regarding the programs under its jurisdiction. The Los Angeles Urban Mathematics/Science/Technology Committee was formed to guide LAEP's programs toward enabling teachers (1) to become a part of the mathematics resource community, (2) to perceive themselves as effective and empowered, and (3) to discover new and effective ways to motivate students. This committee, which grew from 35 members to over 50

members, met annually. In 1989-90, after a year of review by a small advisory group, the committee was reconstituted, resulting in the formation of the LAEP Mathematics/ Science/Technology Council. The newly formed Council did not view its programs solely as empowering teachers and motivating students, but instead set its sights on the reform of education. The charge to the Council directed it to take an active role in seeking opportunities to improve student achievement by promoting and initiating education reform in mathematics, science, and technology.

C. Context

The Los Angeles collaborative is situated in a large metropolitan area that is steadily growing. From 1985 to 1990, the population of Los Angeles county increased by 8 percent, from 7,800,000 to 8,407,440 people. Within Los Angeles County, there are 82 school districts including the Los Angeles Unified School District (LAUSD). Initially, +PLUS+ identified 47 high schools from 11 of the districts as eligible for its departmental planning program; 20 schools in the Los Angeles Unified School District and 27 schools in the other 10 school districts. +PLUS+ began its departmental planning process by working with the mathematics departments from two schools in the LAUSD and one from the El Monte Union High School District. By the end of the 1989-90 school year, +PLUS+ had expanded to 29 departments representing four school districts: Los Angeles Unified School District, Inglewood Unified School District, El Monte Union High School District, and Long Beach Unified School District. Through its departmental team building strategy and its workshop series, +PLUS+ had, by the end of the five-year period, reached nearly 600 teachers from 83 middle, junior high, and high schools in 10 districts.

The Los Angeles Unified School District

During the period from 1985 to 1990, K-12 enrollment in the LAUSD increased 5 percent from approximately 575,000 students to 605,000, with the percentage of non-white students increasing from 80 percent to 85 percent. In 1990, there were 331,317 students in elementary schools; 120,614 in junior high schools; 120,743 in senior high schools; 28,717 in magnet schools and centers; and 3,989 in schools for the handicapped. Of the students enrolled in senior high and opportunity schools, 58 percent were Hispanic,

18 percent white, 15 percent black, 7 percent Asian, 2 percent Filipino, and less than 1 percent American Indian. In 1989-90, 162,710 of the district's students were classified as Limited English Proficiency (LEP), of whom 89 percent were identified as speaking Spanish as their original language. Fifteen percent of all high school students were from families that received AFDC. The annual dropout rate for 1988-89 was 14 percent, calculated from Grades 10, 11, and 12. This was an increase from the reported dropout rate in 1985-86 for Grades 10-12 of 12 percent. Thirty-nine percent of the 10th Grade students in 1985-86 left school over the next three years without receiving a diploma or its equivalent.

Seven persons serve on the LAUSD's School Board. In the 1989-90 school year, the district had approximately $3.87 billion in expenditures, a 29 percent increase from the expenditures of $3 billion in 1985. State funds financed about 79 percent of the district's costs in 1989-90; local taxes covered 11 percent; and federal aid financed 10 percent. In 1985-86, the cost per student (based on average daily attendance) in LAUSD was $3,402. This rose 24 percent, to $4,222, in 1988-89.

During the scope of this report, 1985 through 1990, LAUSD experienced a change in superintendents. At the end of the 1986-87 school year, after having served for five years, Dr. Harry Handler resigned. Dr. Leonard Britton assumed the position of superintendent and chief executive officer in the summer of 1987. The district is comprised of 648 schools--414 elementary schools, 72 junior high schools, 49 senior high schools, and 113 other schools--and 189 centers. One hundred five of the schools and centers operate year-round. During 1989-90, five year-round calendar schedules were followed by these schools.

In 1989-90, LAUSD employed 30,428 teachers compared with 29,221 in 1985-86, a 4 percent increase. In 1989-90, 62 percent of the teachers were white, 18 percent were black, 11 percent were Hispanic, 7 percent were Asian, and 2 percent were from other ethnic groups. The average teacher in the LAUSD is 44 years old, with 15 years spent working in education. Approximately 70 percent of all teachers are members of United Teachers-Los Angeles (UTLA), an affiliate of NEA and AFT. Between the 1986-87 school year and the fall of 1990, the salary range for teachers increased from $20,000-$38,000 to $29,529-$53,938 for 180 contract days. The average salary for a teacher went from $30,337 in 1985-86 to $45,709 in 1990-91, over a 50 percent increase. One factor of

the increase in teachers' salaries was a two-week strike in May, 1989, when over 80 percent of the teachers stayed away from work. A three-year contract settlement ended the strike, the first in Los Angeles County in 19 years.

In 1989-90, 800 teachers taught mathematics in high school. Of these, 66 percent were white, 15 percent black, 11 percent Hispanic, 7 percent Asian, and 1 percent American Indian. Approximately 98 percent of the teachers had bachelor's degrees and 38 percent had master's degrees. Most (85%) of the teachers were certified to teach mathematics, although 15 percent held short-term emergency certifications. The mathematics curriculum is based on the State Model Curriculum Standards and the California *Mathematics Framework*. One year of mathematics in Grades 10-12 is required for high school graduation. Of the 1989 graduating seniors, 37 percent had completed three years of mathematics, the mathematics requirement for admission to the University of California. During 1989-90, 7,947 (an estimated 10%) juniors and seniors were enrolled in advanced mathematics courses.

Several professional enrichment opportunities are available to teachers in the Los Angeles county area. The LAUSD Office of Secondary Instruction, the University of California-Los Angeles (UCLA) Mathematics Project, the Center for Academic Inter-Instructional programs, and the UCLA Graduate School sponsor programs as does the Achievement Council, the California Technology Project, and the Mathematics-Science Interchange of Loyola Marymount University. Through the California Mathematics Project, summer programs for high school mathematics teachers are held at UCLA and California State University-Los Angeles to develop leadership skills and address issues of curriculum and methods. The Los Angeles business community also provides a variety of programs for educators and students.

Inglewood Unified School District

Inglewood is the second largest school district participating in the collaborative. In 1987-88, the district served a student population of 15,807, and in 1989-90, 15,863--consisting of 57 percent black, 39 percent Hispanic, 2 percent white, and 2 percent from other ethnic groups. Twenty-one percent of the student population are LEP students with

Spanish the native language of approximately 97 percent of these. About 40 percent of the students' families receive AFDC support. The annual dropout rate for Grades 10-12 is around 9 percent.

There are five people on the school board, elected for four-year terms. The annual budget for the 1989-90 school year totaled approximately $49 million. Nearly 82 percent of this came from the state, 13 percent from local sources, 5 percent came from federal reserves, and .6 percent was provided by other sources. Dr. George McKenna, who has served as superintendent since 1989, is under a five-year contract. Inglewood's total professional staff in 1990 was 676, a slight increase since 1989. Of these, 48 percent were black, 41 percent white, 6 percent Hispanic, 4 percent Asian, and 1 percent American Indian. The average teacher was 43 years old, with 15 years of experience. Teachers are represented by the Inglewood Teachers' Association. Approximately 200 teachers left the district for the Los Angeles District following the negotiated LAUSD settlement in May, 1989.

There are two high schools in the district, one of which, Morningside High, is a +PLUS+ school. It had a student enrollment of 1,278 in 1990, a drop from 1,400 in 1988. Approximately 70 percent of the students were black, 29 percent Hispanic, and 1 percent from other ethnic groups. Although the cumulative dropout rate is 45 percent, approximately 60 percent of the graduates go on to some form of post-secondary education. At Morningside High, there are ten mathematics teachers. All ten have bachelor's degrees, six have at least a master's degree, and all are certified and tenured.

El Monte Union High School District

El Monte Union High School District (EMUHSD) provides secondary education to an area population of 150,000. In 1989-90, the district had a student population of approximately 9,120, a 12 percent increase from the 8,149 students enrolled in 1987-88. Of the student body, 70 percent were Hispanic, 17 percent were white, 10 were percent Asian, 1 percent were black, and 2 percent from other ethnic groups. Twenty-two percent were classified as LEP students; 80 percent of these spoke Spanish as their native language. During the 1989-90 school year, 18 percent of the students came from families that

received AFDC support. The annual dropout rate for students in Grades 10-12 was approximately 11 percent for the 1987-88 school year.

EMUHSD has a school board of five people, elected for four-year terms. The annual school year budget was over $30 million in 1989-90, an increase from $28 million in 1987-88. Approximately 80 percent came from state funds, 14 percent from local revenue, 5 percent from federal funding, and about 1.4 percent from outside sources.

Dr. James J. Sheridan has served as superintendent for over 15 years. The district has four high schools and a continuation school for students 16 years of age and older. One of the schools, Mountain View High School, is a +PLUS+ collaborative school and had a 1989-90 student population of 2,155. The ethnic composition was 85 percent Hispanic, 8 percent white, 6 percent Asian, less than one percent American Indian, and less than one percent black.

El Monte's professional staff totaled 394, a slight increase from the 1988-89 school year, but down by 10 since the 1987-88 school year. Of this number, 74 percent were white, 19 percent were Hispanic, 4 percent were Asian, 2 percent were black, and 1 percent were of some other ethnic background. The average teacher was 43 years old, with 15 years of teaching experience.

Teachers are represented by the District Education Association and their salaries range from $25,289 to $49,943. Ninety-nine percent of the staff have a bachelor's degree; 41 percent have a bachelor's plus 30 credits, and 36 percent have a master's plus 30 credits.

Long Beach Unified School District

The Long Beach Unified School District draws from a population area of 476,519. In 1989-90, there were 5 senior high schools, one combination senior high and junior high school, 8 junior high schools, 6 middle schools, and 57 elementary schools. Two high schools from the district, Millikan High School and Long Beach Polytechnic High School, are +PLUS+ schools. The district's total K-12 enrollment was 69,106. Of the 17,708 students enrolled in senior high schools, 35 percent were white, 25 percent were Hispanic, 19 percent were black, 14 percent were Asian, and 7 percent were from other ethnic

groups. There were 3,455 certified staff employed in the 1989-90 school year. About 10 percent of juniors were enrolled in advanced mathematics classes. In 1988-89, the district expenditure per student was $3,510.40.

D. Management Structure

The development of the +PLUS+ collaborative has varied from the pattern at other sites in its emphasis on collaboration between teachers and the business and university sectors on a smaller but more intensive level. It operated on the premise that the basic unit of reform was the mathematics department in individual schools. It was believed that by working with whole departments of teachers, the project could build intradepartmental cohesion and that these departments could ultimately disseminate their strategies for empowerment to other schools in the district. Three schools (Manual Arts and Wilson High School in the LAUSD, and Mountain View High School in the El Monte School District) were selected as initial target sites. Mathematics departments in each of the three schools were given $2,500 to develop and implement an Action Plan. Each Plan outlined its team's goals and objectives, proposed activities, and described potential outcomes.

The host agent for the +PLUS+ project is the Los Angeles Educational Partnership (LAEP), a private nonprofit organization founded in 1984. Initially the Ford Foundation made contact with Peggy Funkhouser, the executive director of LAEP, with the objective of launching an Urban Mathematics Collaborative in the Los Angeles area. Toby Bornstein, a former elementary and junior high teacher, was hired as a consultant to prepare the funding proposal. The initial commitment of support for the collaborative came from the LAEP Board, three university campuses, the Los Angeles County Office of Education, the LAUSD, seven major corporations in the Los Angeles area, the California Community Foundation, and the Los Angeles Museum of Science and Industry.

Peggy Funkhouser, also executive director of the Urban Mathematics/Science/ Technology Collaborative, oversees the direction and policy of LAEP's various projects, including the +PLUS+ project, one of its Mathematics/Science components. Toby Bornstein was selected as the coordinator of the project at the end of the 1984-85 school year and continues to be a strong influence on the development of the +PLUS+ collaborative. She has a full-time administrative assistant and a teacher coordinator on

staff. Kathy Blackwood, a teacher at Venice High School, served as full-time teacher coordinator between the spring semester of 1989 and spring of 1990, when she returned to half-time teaching and served half-time as teacher-coordinator. After attending the early +PLUS+ teacher workshops, Ms. Blackwood became interested in assuming an active role in the collaborative; her participation and leadership have increased as the collaborative has developed. In spring of 1990, Joan Hairston, a mathematics teacher at Dorsey High School, assumed the half-time teacher coordinator position concurrent with Ms. Blackwood. In her role as teacher coordinator, Ms. Hairston chairs the Teachers' Council, and attends to administrative responsibilities for operating +PLUS+.

The Urban Mathematics/Science/Technology Committee was an advisory committee to the Board of the LAEP, overseeing its three mathematics and science projects: The Model Technology Project, Professional Links with Urban Schools (+PLUS+), and Target Science. The Urban Mathematics/Science/Technology Committee, formed to administer the financial and educational policy of the collaborative, was composed of 57 members, including 9 teachers from +PLUS+ schools, 12 administrators and supervisors from the targeted districts (LAUSD, Los Angeles County, El Monte, Pasadena Unified, and Inglewood), 18 members from higher education institutions, 14 from business and industry, and 4 from local community organizations. In the spring of 1990, LAEP reconstituted the committee in an effort to better serve the needs of LAEP projects, initiate some form of representative governing structure, and increase the effectiveness of the project as a mathematics and science advocate with the participating districts' school boards and the LAEP Board.

The Teachers' Council

The Teachers' Council has emerged as the major decision-making body for +PLUS+. Initially, the Teachers' Council was an informal group comprised of teachers from the three originally targeted mathematics departments, who met occasionally to share information on their departments' activities. As the collaborative matured, the role of the Teachers' Council became more formal, addressing the needs of the collaborative as a whole as well as sharing the concerns of the individual departments. A major outcome has been the Council's role as an agent for curriculum change, focusing on the need to interact with curriculum decision makers. By the 1988-89 school year, the Teachers' Council

became the central decision-making body for +PLUS+, taking the initiative toward a more active role for the collaborative.

To better accommodate the needs of the new schools and districts that joined the collaborative, the structure of the Teachers' Council changed dramatically over the years, evolving from an informal organization into a representative governing body made up of 21 teachers (one from each school represented in the collaborative). Teachers on the Council are further organized into four Satellite Councils representing geographic regions of the Los Angeles area. Each Satellite Council is facilitated by a teacher coordinator who is released by the district on a part-time basis. The collaborative had planned for each teacher coordinator to spend up to a year being trained at the +PLUS+ office, but because of the need to form the four Satellite Councils earlier than anticipated, only two of the coordinators went through the formal training at the +PLUS+ office. Each Satellite Council has the power to make its own decisions regarding professional development grants, continuation grants, new school recruiting, classroom demonstrations, and allocation of resource teachers.

As the major decision-making body for +PLUS+, the Teachers' Council's major functions are to allocate funds for continuation grants and professional development grants, to raise professionalism issues within each of the Satellite Councils, and to inform Council members about issues that pertain to leadership development. The Council also has established teacher committees to plan programs and address key issues. In 1990, four standing committees were established: The Jaimé Escalante Mathematics Teacher Awards, the +PLUS+ Workshops Committee, the Annual Conference Committee, and the Communications Committee (Newsletter and +TV). The teacher coordinator, who serves on all four committees, functions as the link among the committees. When the Satellite Councils are in full operation, the original Teachers' Council will be dissolved.

Expansion

One of the recurring issues, which is unique to the +PLUS+ collaborative because of the large number of school districts in Los Angeles County, is that of scale. By the end of the 1987-88 school year, one-quarter of the eligible schools had participated in the +PLUS+ department program. In addition, teachers from 37 high schools had attended the

+PLUS+ sponsored workshop series in 1987-88, and teachers from 79 secondary schools from 12 districts within Los Angeles County had attended at least one collaborative function. Although this represents a large number of teachers, there remains a larger number of eligible teachers in Los Angeles who were not involved.

Both the Teachers' Council and the LAEP were interested in expanding the collaborative to include more teachers. In the spring of 1988, LAEP Executive Director Peggy Funkhouser appointed a Planning for Permanence Task Force to outline possible future directions for the +PLUS+ project, and the LAUSD Board of Education approved an expenditure of $900,000 to expand the +PLUS+ project. As a result of this focus on outreach, by the end of the 1987-88 school year, the number of targeted mathematics departments had increased from 3 to 15, and 327 teachers had attended collaborative functions. By spring, 1990, the number of departments in the collaborative reached 29, with over 600 teachers in the Los Angeles area having attended a collaborative activity.

Criteria for inclusion as a new +PLUS+ department include recruiting at least 60 percent of the teachers in the mathematics department as collaborative members and obtaining an endorsement of the Action Plan (developed by the collaborative teachers) by all the teachers in the department.

E. Project Activities

Over the five-year period 1985-1990, +PLUS+ sponsored a wide variety of activities for mathematics teachers in the greater Los Angeles area under the auspices of the Los Angeles Urban Mathematics/Science/ Technology Collaborative. The collaborative's primary strategy during this time was to focus on developing leadership and cohesiveness in the mathematics departments of targeted high schools in the Los Angeles area. In addition, the collaborative sponsored a variety of activities for all of the mathematics teachers in the area.

In reflecting on the years of data collection for the Urban Mathematics Collaborative project, four themes emerged from the documentation process as being dominant in collaborative programming for nearly all of the collaboratives. These themes were: Socialization and Networking, Knowledge of Mathematics Education, Teacher

Professionalism, and Teacher Leadership. Socialization and Networking activities, typically prominent in the formative years of the collaboratives, were designed primarily to initiate interaction and networking among teachers and between teachers and mathematicians from business and higher education. The second theme, Knowledge of Mathematics Education, encompassed activities designed to provide teachers with mathematics-directed experiences and to increase the knowledge of teachers and others regarding current trends in mathematics and mathematics education. Many of these activities helped to activate the agenda of the mathematics reform movement at the collaborative sites. The third theme, Teacher Professionalism, emerged in activities structured to enhance teachers' conceptions of teaching as a profession. Collaboratives provided opportunities and incentives for teachers to attend professional organization meetings and made teachers aware of grants and other opportunities. Some collaboratives paid teachers' membership dues to encourage them to join mathematics organizations and arranged for teachers to observe other teachers and reflect on their teaching. The fourth theme was Teacher Leadership. The Los Angeles Collaborative was unique in that it made Teacher Leadership its primary focus from the onset, guiding the development of most of the collaborative's programming. In general, developing teacher leadership was not the initial objective of the other collaboratives and only gained attention as collaboratives found that teachers lacked the skills needed to organize, plan, and develop the power within their group to generate systemic change. The Teacher Leadership theme was further advanced by the EDC through the UMC Teacher Leadership Workshops which, beginning in the summer of 1989, were attended by from one to four teachers from each of the collaboratives. However, since this training was initiated by the EDC rather than by individual collaboratives, it is not discussed in the reports of the individual collaboratives.

In reflecting on +PLUS+ activities as they related to the four themes, there was considerable overlap, although, clearly, the overriding focus of +PLUS+ programming was teacher leadership. While the collaborative did promote socialization as a key objective in order to create a mathematics resource network, the collaborative did not sponsor "purely social" functions; each activity had a specific focus in addition to promoting networking. Most often, the focus was on increasing teachers' leadership abilities or their knowledge of mathematics education. Furthermore, many of the activities designed to promote teacher leadership also served to enhance teachers' views of themselves as professionals. Consequently, in the review of the collaborative's activities that follows, the four general

themes discussed above are not as sharply distinguished as they are in the summaries of the other collaboratives.

Teacher Leadership

In the +PLUS+ focus on developing teacher leadership and team building, the school mathematics department has from the beginning been the center of its efforts. Some activities were planned for all +PLUS+ departments, including retreats and conferences, and +PLUS+ departments also held their own programs. In addition to programming that focused on the departments, +PLUS+ sponsored an annual workshop series for all area teachers. As the collaborative matured, teachers assumed greater leadership and responsibility for these activities.

Department Action Plans and Continuation Grants

Each targeted +PLUS+ department was charged with writing an Action Plan to address an issue that the department members felt needed action. The collaborative issued grants of $2,500 for departments to implement their plans. The plans that were generated are resulting in important changes in the schools. The focus of one department's plan, for example, was on increasing the enrollment of 9th graders taking algebra; another department initiated an early morning algebra class so that students having difficulty could have two periods of algebra each day instead of one.

+PLUS+ began in 1985 with three targeted high school mathematics departments, and then each year added new departments following a procedure that was carefully developed, evaluated, and refined so that by the end of the 1989-90 school year, there were 29 +PLUS+ departments. In general, the procedure began with informational meetings in the fall in an effort to make unaffiliated departments aware of the opportunity to join +PLUS+. Departments that applied for collaborative membership then participated in training and planning sessions to develop their Action Plan proposals, with members of current +PLUS+ departments serving as facilitators. In addition, a team of +PLUS+ members, including +PLUS+ staff, made site visits to each prospective department. In the spring, these departments presented their preliminary proposals to each other as well as to

current +PLUS+ teachers, and then had an opportunity to incorporate this feedback into their final proposal. Either late in the school year, or early in the fall of the following year, the department grants were announced and checks presented at a reception. Throughout the process, individual +PLUS+ teachers served in leadership positions. In the 1989-90 school year, when the collaborative was at a point at which the application process for newly participating departments had been adequately refined, +PLUS+ initiated Continuation Grants that enabled 1986 and 1987 +PLUS+ departments to apply for new funding. Another cycle of Continuation Grants began in the spring of 1990. This strategy ensured that existing +PLUS+ departments would continue their team-building efforts.

+PLUS Department Site Visits

Each +PLUS+ department held its own meetings and programs during the school year and also participated in a variety of activities sponsored by +PLUS+. Beginning in the fall of the 1988-89 school year, each of the new +PLUS+ schools hosted department site meetings to help integrate new schools into the already existing +PLUS+ network. The meetings also provided an opportunity for teachers to explore topics in mathematics and mathematics education that the host school identified. Teachers took a leadership role in planing these meetings and in presenting the programs.

+PLUS+ Retreats and Annual Conferences

Over the five-year period, +PLUS+ sponsored two retreats and two annual conferences for members of the +PLUS+ departments. The retreats were held in the fall and spring of the 1987-88 school year. The Fall Retreat offered a mixture of classroom expertise and group interaction, while the Spring Retreat was designed to offer +PLUS+ participants an opportunity to reflect on the impact that +PLUS+ membership had on each department as well as to help the departments plan for the future. Both retreats were planned primarily by the collaborative director, although teachers played an active leadership role during retreat sessions and discussions. By way of contrast, teachers played a key leadership role in organizing and planning the two +PLUS+ Annual Conferences, held in the spring of 1989 and spring of 1990. Teachers participated in planning meetings

for the first Annual Conference, minimizing the role of the collaborative director. The Second Annual Conference was planned entirely by teachers, with a three-member teacher committee assuming complete responsibility for this important professional development activity. Programming at the 1989 Annual Conference included a focus on the issues of communication, permanence, leadership, and evaluation, as well as four mini-workshops on the latest available technology. Participants also met by department to evaluate what had happened during the year and to look ahead to the goals for the coming year. Programming at the 1990 Annual Conference addressed key topics such as by-laws, leadership and communication, and the structure for a satellite Teachers' Council. At both conferences, participants had the opportunity to vote on which continuing +PLUS+ departments should receive $250 implementation awards for the progress they made on their action plans.

+PLUS+ Workshop Series

A significant amount of the project's time and resources each year were devoted to the annual +PLUS+ Workshop Series, which was first initiated in 1986-87. The workshops in the series were planned and in some cases conducted by teams of teachers working with colleagues from industry and university communities, with teachers playing a leadership role in planning and presenting as well as in facilitating the workshops. The workshops were administered by teacher coordinators, who were also responsible for ensuring that workshop ideas were fieldtested and the results shared. Special training sessions that included instruction on cooperative learning techniques were held for coordinators and presenters.

As with other +PLUS+ programs, evaluation was an integral part of the process. The teacher coordinators met after each session to evaluate and to assess progress toward workshop goals. In addition, in the spring, an evaluation meeting was held to enable the teachers on the planning committee to carefully review all aspects of the Workshop Series and to begin to plan for the following year. At the workshop evaluation meetings, the committee also selected the teachers who were to receive the $200 grants for submitting the best fieldtested idea from each session.

LAEP Leadership Conference

In January, 1990, the Los Angeles Educational Partnership (LAEP) , in cooperation with the Educational Development Center (EDC) and the Los Angeles Unified School District, hosted a three-day leadership conference for teachers in three LAEP projects, including +PLUS+. Twelve teachers from each project participated in the conference, which was led by EDC consultant Grady McGonagill. The superintendent of the Los Angeles Unified School District had lunch with the participants, giving the teachers an opportunity to talk with him informally.

Professionalism

One of the major goals of +PLUS+ in providing team-building and leadership training to teachers was to enhance their professional status. The annual conferences and retreats, as well as the +PLUS+ Workshop Series, all contributed to the teachers' growing perception of themselves as professionals. In addition to these programs, +PLUS+ initiated several other programs to heighten teachers' sense of their professionalism.

Jaimé Escalante Mathematics Teacher Awards

During the 1988-89 school year, the +PLUS+ Teachers' Council initiated and administered the Jaimé Escalante Mathematics Teacher Awards. The award program, which is funded by the ARCO Foundation, seeks to reward teachers who have motivated students to achieve in mathematics. The newly created award elicited more than 500 nominations from current and former LA County public school students who wrote essays on their teachers' unique qualifications. During the 1989-90 school year, there were 86 nominations for 33 teachers. Using a screening procedure that was implemented in 1988-89 and refined in 1989-90, three $1,000 Jaimé Escalante awards and seven $500 awards were presented each year.

Demonstration Lessons

In the spring of 1989, +PLUS+ initiated a series of on-site classroom demonstrations to enable teachers to visit other teachers' classes in order to observe their teaching. This activity provided the teachers with a rare opportunity--the chance to reflect critically on the teaching of others as well as on their own. Following each demonstration lesson, the host teachers were available to discuss what occurred in the classroom. Two demonstration lessons were held during the 1988-89 school year and eight were held during the 1989-90 school year. In order to provide more teachers with the opportunity to observe the variety of mathematics teaching strategies being demonstrated in the classrooms, the sessions were videotaped. Teachers who attended the demonstration could show the tape to their departments, thereby expanding the impact of the program.

LAEP Small Grants Program

+PLUS+ teachers have the opportunity to apply for grants from the LAEP Small Grants for Teachers program. Since the program began, the partnership has distributed $850,587 to 2,700 teachers in 502 Los Angeles district schools. The grants are awarded to teams of teachers with creative ideas and the dedication to make a difference in education and, in so doing, to recognize teachers as professionals and demonstrate community trust and support for their efforts. Two +PLUS+ teachers, for example, received a small grant to develop a course component in fractal geometry; their proposal combined lectures and laboratories for students that were designed to expand the use of elementary concepts in mathematics and science. In addition to the LAEP Small Grants Program, mathematics, science, and technology grants were available to Los Angeles teachers provided by GTE California, Hughes Aircraft, Lockheed Corporation, McDonnell Douglas, Northrop Corporation, Rockwell International, and TRW Foundation.

Professional Development Grants

Beginning in the 1985-86 school year, +PLUS+ offered professional development grants that enabled teachers to attend local, regional, and national conferences. The grant program was designed to foster teachers' interest in new ideas and to revitalize their

professional associations. During the 1989-90 school year, for example, a total of $10,000 was awarded to 47 teachers. Among the conferences teachers attended with the support of professional development grants are the annual meetings of the National Council of Teachers of Mathematics, the California Mathematics Council Annual Conference and sectional meetings, annual conferences on Secondary School Mathematics and Computers at Phillips Exeter Academy, Woodrow Wilson Institutes, the National Science Teachers' Convention, conferences at the North Carolina School of Science and Mathematics, the Mathematics Science Technology Institute at Berkeley, and Apple Fest '88.

Knowledge of Mathematics Education

One of the goals of +PLUS+ was to provide teachers with a more enlightened view of the uses of mathematics and to encourage them to implement new ideas in the classroom. This was accomplished through a variety of programs, including the +PLUS+ Workshop Series, the 1987-88 Retreats and Annual +PLUS+ Conferences, the Demonstration Lessons, and Woodrow Wilson Institutes.

+PLUS+ Workshop Series

The +PLUS+ Workshop Series, which the collaborative has conducted each year for teachers in the Los Angeles area, was initiated to enable +PLUS+ to reach a large number of teachers at the middle school level as well as at the secondary level to inform them of the current recommendations for teaching mathematics. The workshops were designed to update knowledge and demonstrate applications and simulations from the world of work, with emphasis on the strands of the California *Mathematics Framework* and the NCTM *Curriculum and Evaluation Standards*. Since the series was first initiated during the 1986-87 school year, over 300 teachers have participated in one or more of the workshops. The workshops, addressing a variety of topics, were held over a series of four Saturdays. During the first year, workshops on four different topics were offered, whereas by the 1989-90 school year, participating teachers were able to choose from among ten different topics. In the 1989-90 Workshop Series, for example, workshops were offered on quantitative literacy, alternative algebra approaches, the *Geometric Supposer* software.

manipulatives, calculators, graphing calculators, and mathematical modeling. The workshops allowed participants the opportunity to fieldtest ideas in the classroom and to share the result with their colleagues.

Retreats and Annual Conferences

While the retreats and annual conferences sponsored by +PLUS+ focused primarily on team building and on leadership skills, a part of each program was devoted to expanding teachers' knowledge of mathematics education as well as their expertise in the classroom. The 1987 Fall Retreat, for example, included a session on technology in the classroom, while at the 1988 Spring Retreat, teachers participated in a discussion, "Teaching Math in the Year 2000." On the second day of the First Annual +PLUS+ Conference, mini-workshops were conducted on the latest available technology: graphing calculators, math videos, the *Geometric Supposer*, and other mathematics software. Topics addressed at sessions at the Second +PLUS+ Annual Conference included equity, curriculum and assessment, and technology.

Demonstration Lessons

The series of demonstration lessons conducted during the 1988-89 and 1989-90 school years also provided teachers with an opportunity to increase their knowledge of mathematics education. The focus of demonstration lessons included the use of graphing calculators in the classroom, algebra manipulatives, the *Geometric Supposer*, computer software, word problems, "build-a-book" geometry, and precalculus.

Woodrow Wilson Institutes and Follow-Up Workshops

In the summers of 1988 and 1989, the collaborative, with support from the LAEP and the LAUSD, was able to bring outstanding mathematics institutes to Los Angeles, sponsored by the Woodrow Wilson Fellowship Foundation. In August, 1988, the collaborative sponsored a Woodrow Wilson Geometry Institute, a one-week institute

focusing on new approaches to teaching geometry. Presentations addressed new directions in the content and teaching of high school geometry. Twenty-six people participated in the Institute, including 17 teachers. In the summer of 1989, +PLUS+ sponsored a Woodrow Wilson Institute on Mathematical Modeling. The primary focus of the Institute was on using mathematics to describe real-world events and to solve actual problems. The content was designed to enhance the mainstream secondary school curriculum, from arithmetic and algebra through precalculus. Eleven +PLUS+ teachers as well as 20 participants from the LAUSD and LA County Schools participated in the institute.

In the spring following each institute, a follow-up session was held for institute participants. Most of the 1989 session was devoted to participants' presentations of the ideas they had fieldtested during the year. Several teachers who had participated in the 1988-89 +PLUS+ Workshop Series on geometric manipulatives also participated in this follow-up session. At the 1990 follow-up session, in addition to sharing ideas they had fieldtested, teachers discussed the reform movement in mathematics education, including curriculum, teaching techniques, and means of assessment. The topic of fractals was also introduced.

Socialization and Networking

While the creation of a collaborative network of teachers was one of the goals of +PLUS+, the collaborative did not offer activities purely to promote socialization. Yet, socialization and building strong collegial relations were a part of all +PLUS+ activities. The collaborative retreats were designed, in part, to provide teachers with an opportunity to meet with members of their own departments as well as to network with teachers from other +PLUS+ departments. The Fall Retreat, for example, ended with a wine and cheese reception. Yet, in general, the retreats focused primarily on planning and team-building activities. Similarly, while the two annual conferences provided teachers with an opportunity to get to know each other better, the primary focus of the conferences was on addressing issues pertaining to collaborative planning and teacher leadership. Two additional collaborative initiatives, TELE-Venture and *NON +PLUS+ED*, the collaborative newsletter, helped to facilitate communication among collaborative teachers.

TELE-Venture

During the 1987-88 school year, +PLUS+ arranged for the seven departments that were +PLUS+ members at the time to receive modems and telephone lines to link into the electronic bulletin board TELE-Venture. The system offered teachers an opportunity to exchange information as well as to participate in forums on critical issues affecting mathematics teachers. By the 1989-90 school year, teachers in 21 +PLUS+ departments, as well as several science teachers and district instructional specialists, were using the network. Department team leads were encouraged to use auxiliary personnel to log on daily, send messages to department members, and announce meetings. It was anticipated that by June, 1990, TELE-Venture would become the primary means of communication between teachers and the +PLUS+ administrative staff.

NON +PLUS+ED

The collaborative initiated the publication of a monthly collaborative newsletter, *NON +PLUS+ ED*, in April, 1989. Designed to keep collaborative members informed and involved, the newsletter is distributed to all +PLUS+ teachers and district staff, as well as representatives of the UMC Network. +PLUS+ members are encouraged to contribute to the newsletter. Two teachers serve as the editorial staff, with assistance from the collaborative's administrative assistant.

F. Reflections

The initial goals set for +PLUS+--networking, broadening teachers' knowledge, increasing students' interest in mathematics, and team building--remained intact throughout the reporting period. A major force in maintaining this consistency was the project director, Toby Bornstein. She believed that if the collaborative were to be a viable operation, it was necessary to set goals and develop a plan to achieve those goals. This philosophy provided the foundation for the development of the collaborative. The collaborative identified the general approach by which it would develop teacher leadership through team building. More specifically, the approach was to work with school

mathematics departments to develop a leadership cadre that could bring changes within the school. The goals of the collaborative were then refined to establish state and nationwide networks of mathematics educators and to influence the district's curriculum. As it developed, +PLUS+ sponsored several activities in addition to the department planning process, including workshops to strengthen the collaborative organization and address teacher leadership development. +PLUS+ trained teacher coordinators to assume greater leadership initiative, conducted classroom visits by teachers, formed Satellite Teachers' Councils, instituted an annual spring conference, and created the very successful annual +PLUS+ Workshop Series.

+PLUS+ and the other science and technology programs of the Los Angeles Educational Partnership has had a direct effect on LAEP's Advisory Committee. In 1985, the Advisory Committee assisted the projects in developing teacher empowerment initiatives. In 1990, the Committee was reconstituted to include corporate representatives, who focused on the improvement of student achievement through educational reform, a greater challenge than focusing primarily on teachers. Thus, +PLUS+ has adhered to its original course, while at the same time helping to expand the potential of its parent organization, the Los Angeles Education Partnership.

+PLUS+ has successfully developed a core of 30 to 50 teachers who are actively engaged in planning and decision making, leading workshops, and exchanging ideas among collaborative members. Through their interaction with +PLUS+, these teachers have assumed new leadership roles within their departments, their districts, and, in some cases, in the state and nation. The collaborative has been able to develop an outreach model that has involved over 600 teachers through a series of workshops led by teachers, professors, and business associates. The departmental planning process has been refined so that teachers are the primary resources for training other teachers. Teachers from the 29 departments who have gone through the process gained experience in working as a group to achieve departmental goals. The departmental plans have led to changes in the mathematics programs, including increased numbers of students in algebra, the availability of extra help for lower-achieving students, and student incentive programs. The Teachers' Council has evolved from an informal group into formal Satellite Councils, each making decisions for collaboration in its own area and addressing important issues such as fund raising. +PLUS+ has always worked closely with the LAUSD. This relationship has been mutually beneficial; the district has supported the work of +PLUS+ financially, while

+PLUS+ has helped motivate teachers to experiment with new courses. The collaborative has also increased the visibility of mathematics teachers with the LAUSD mathematics supervisor, which has resulted in an increased interaction between them. When the mathematics supervisor formed a mathematics advisory group, for example, many of its members were teachers active in +PLUS+. Furthermore, +PLUS+ has continually directed its attention to teachers, providing opportunities for teachers to learn from each other and to develop the means for presenting mathematics in the spirit of the state and national reform efforts. One notable impact of this emphasis has been to diminish some of the barriers that previously prohibited teachers from visiting other teachers' classrooms. The classroom visitations have created the opportunity for teachers to become more reflective about their own and others' teaching, a situation that rarely occurs because of the strong pressure to isolate teachers in their classrooms. Thus, +PLUS+ has successfully generated a program that has brought new knowledge of mathematics and the teaching of mathematics to teachers, has developed their leadership skills, and has enabled teachers to communicate more with each other as well as to build on the experience of other teachers.

+PLUS+ has reached a state of development beyond that anticipated at the time it was established. This has been accomplished through commitment and the work of many people. Even with its successes, some +PLUS+ goals, such as the development of associate pairs, have been difficult to achieve. During the collaborative's first two years, an effort was made to connect teachers with representatives from business and industry, in particular, and with individuals in higher education. After the connections were made, it was left to the individuals to maintain the relationships. In most cases, the relationship did not continue for an extended period of time. One association that did last for three years involved two teachers, a professor from the California Institute of Technology, and engineers from Hughes Aircraft. This group worked together to plan and present a workshop on applications of mathematics. In general, however, the associations that developed represented isolated instances rather than a network of professional support. A second difficulty +PLUS+ experienced was retaining the interest of teachers who had gone through the departmental planning process. In some schools, only two or three teachers (the department lead teacher and one or two others) remained active in +PLUS+ activities after the implementation year. A number of teachers were willing to go along with the departmental plan, but did not reach beyond this. Attempts were made to keep the interest of teachers by offering continuation grants, but this was not always enough. It appeared that teachers who had assumed responsibility or who had attended a special event

through +PLUS+ support were more apt to remain active. The team-building efforts through +PLUS+ worked up to a point, but a department also needed strong leadership within to sustain team work. A third difficulty +PLUS+ faced was in having teachers critique what they and other teachers were doing. Although the workshops, the departmental planning process, and the classroom visits all provided opportunities for critical reflection on the part of the teacher, this process was very difficult for teachers and there were few observable results. As the documentation period ended, classroom visits became more successful as teachers, who were becoming comfortable with classroom critique, openly discussed teaching.

In reflecting upon the five years of +PLUS+, several achievements of the collaborative are noteworthy. Pursuing a clear vision under the guidance of a person who continually exerted pressure to attain that vision has worked well for the Los Angeles collaborative. The collaborative, offered the challenge and financial support to address the problem of scale, generated a plan that doubled its size in two years and reached over half of the high schools in participating districts. The question still remains regarding how to work with all of the teachers in a mathematics department rather than with the 60 percent that is the minimum requirement. If the department is the functioning unit and, as such, is critical in effecting change, then the whole department needs to be involved. It was difficult in some departments, and impossible in others, to get all members to buy into the +PLUS+ process. What would it take to get the entire department involved to some significant degree so that all members are working toward a common goal? The answer to this question probably would have required a shift in goals, from an emphasis on skills development in planning and implementation to a focus encouraging all department members to join in a common effort. This shift would in turn probably also require a different approach. Rather than having teachers from different schools assemble at a central location to be trained, facilitators would go to the schools where they could work with entire departments. With the exception of requiring full participation by a department, hindsight does not provide much help.

Collaboration Outcomes

The major form of collaboration in +PLUS+ is among teachers. The structures that have been created and are in place encourage teacher collaboration. The Satellite

Teachers' Councils, the Workshop Series, the classroom visits, and the departmental planning process all are focused primarily on teachers working with other teachers. The collaboration among teachers has resulted in one of the most important outcomes of +PLUS+--networking among teachers and between teachers and others associated with +PLUS+. A teacher from a 1989 +PLUS+ school valued the insight gained as a result of talking with others, "What I have learned this semester . . . is that I have to keep on talking. If I have a question or concern I have to talk about it and then Toby, or someone can direct me to somebody else. . . . I think the power is in the communication." Another teacher put it simply, "The whole concept of collaboration itself is [that] two heads are better than one." The networking among teachers has given them a support group, a rich source of ideas, and a visible organization that is recognized as an active force when mathematics education in the Los Angeles area is addressed.

In 1989-90, teachers began visiting other teachers' classes to observe their teaching and to reflect critically on their own and others' teaching. +PLUS+ teachers also are used as resources by teachers in other collaboratives through the national electronic network. The evidence that +PLUS+ has enhanced the professional lives of teachers is supported by the high percentage of +PLUS+ teachers who indicated on the 1990 administration of the Survey of Teacher Professionalism that this was the case.

A few mathematics teachers have had significant interactions with representatives from industry and business through the Teacher Associate Pairs program or in presenting a workshop. The departmental grants also have generated some projects that promoted collaboration. A +PLUS+ team lead at one school reported that the continuation grant proposal included a provision for making contacts with local businesses in order to develop community resources. However, a large number of mathematics teachers who are active in +PLUS+ have not experienced interaction with representatives from other sectors.

Professionalism Outcomes

One way in which the collaborative enhances the professional lives of teachers is by extending the number of teachers available whom a teacher can call upon for support and new ideas. This expanded support group gives teachers encouragement and confidence. The collaborative, according to a department chair, "gives you the feeling that

you are moving toward accomplishment . . . and that you have control over making your profession better." This relates to the outcome of the collaborative most frequently noted by teachers--networking among the members of their profession. This has been observed by the district mathematics supervisor, who described the improvement in the working relationship among teachers in a department as an important outcome of the collaborative: "I see more of the people within a department talking to each other and helping each other."

The Survey of Teacher Professionalism was administered to a sample of +PLUS+ teachers in 1986 and again in 1990. In regard to autonomy and to making and reviewing decisions in teaching, the Los Angeles teachers had the second highest mean score of the ten collaboratives who participated in the first survey. On the readministration of the Professionalism Survey in 1990, the Los Angeles teachers had the highest mean score of the eleven collaboratives. For the 12 +PLUS+ teachers who took both surveys, there was a small increase in the scale mean indicating some effect of collaborative participation. On an item that asked if the collaborative had facilitated the development of leadership, Frequent participants in the collaborative had a significantly higher mean score than Occasional participants, indicating that those who have been most active in +PLUS+ have benefited the most in the development of leadership.

+PLUS+ has fostered structural change in some mathematics departments. Some of the +PLUS+ departments have team leads who are different from the department heads. One teacher assuming this position reported that the responsibilities of the team lead complemented those of the department head so that more was accomplished. This structure serves to distribute leadership responsibilities among a greater number of teachers. The team lead is given either some additional money or a released period. Some departments were creative in deciding how this time is used and shared the released time with other teachers.

+PLUS+ has changed the professional climate for at least some of the mathematics teachers in the Los Angeles area; they are exhibiting leadership in new ways, talking with one another and sharing ideas, specifying goals, and working together toward achieving those goals. An increasing number of teachers are taking advantage of site visits and are becoming more reflective regarding teaching. They have an increased awareness of professional development and an interest in actively seeking and taking advantage of

available opportunities. A few teachers are serving on district committees. The creation of this climate was the result of work by many teachers and others, but it can also be attributed to the vision of the project director. When asked in the beginning about what she thought the program should be, Ms. Bornstein commented, "I believed that we could cause it to happen . . . by giving [a group of mathematics teachers who really wanted to see change happen] opportunities to grow . . . to learn and to lead . . . [so] that there would be one day an organization that would enable them to pursue their professional goals." What had to be in place for this to happen was for teachers "to feel support . . . have autonomy in making decisions . . . [the belief that if they] have a goal and stick to a plan . . . they could make things happen."

Mathematics Focus Outcomes

+PLUS+ has demonstrated the effectiveness of its focus on the professional development of teachers in terms of the number of teachers who have been attracted to its activities. Although data are not available on the impact of +PLUS+ on all of the teachers who have participated in collaborative activities, interviews and survey data from teachers who have attended some activities reveal that +PLUS+-sponsored activities have changed teachers' beliefs of what students should know about mathematics, increased teachers' knowledge of mathematics, and affected their classroom practices. One teacher developed a discrete mathematics course after attending a +PLUS+ workshop. Other teachers changed their approach to teaching geometry by having students use computer software to generate and test their own conjectures. Another teacher developed a no-textbook geometry course in which students write their own textbook. When asked how the collaborative has affected their goals for teaching mathematics, four of the five teachers interviewed gave positive responses, such as "concepts are far more important than calculations," "now students formulate problems," and "goals have expanded." Teachers also acknowledge that the collaborative has expanded their conceptions of mathematics.

The departmental grants are providing teachers with an opportunity to address the resolution of problems in the teaching of mathematics. One department, for example, wanted to encourage more students to continue with algebra. This department developed an early morning algebra class as its +PLUS+ project in order to provide extra support for students. One result was that in 1989-90, a higher percentage of the school's Algebra IA

students advanced to Algebra 1B than in previous years. This program was made possible at no additional cost to the department; a mathematics teacher arrives an hour earlier at school to teach the class, and then finishes the school day one hour earlier.

Another positive outcome of +PLUS+ has been the sharing of ideas among teachers as they become more comfortable with the process of working together. One teacher, in illustrating the value of having mathematics teachers communicating regularly with each other, noted that before +PLUS+ existed, whenever mathematics teachers got together, the initial activity consisted of venting their anger, "It is like there is all this pressure built up in the individual . . . when you finally have someone who you know would understand . . . then you can go on to problem solving." Since the advent of the collaborative, the teachers communicate more effectively with each other, experiencing more productive interaction. In a discussion regarding the difficulty a teacher was having in describing the set of real numbers to algebra students, another teacher shared her idea of using nested boxes, the largest one representing the real number; inside this box were two, smaller boxes--one for rational numbers and one for irrational numbers; and so on. The teacher said, ". . . you could view in ten minutes what you have been tearing your hair out to get across in an hour without success. . . . It was one of those things where I as a teacher, and my students benefited, from this whole idea of collaboration." She went on to note, "As we as a department get stronger, we cannot, as individual teachers, help but reflect on our students' achievements."

+PLUS+ is making a significant impact on mathematics education in the Los Angeles area. +PLUS+ has attracted the attention of the LAUSD Board of Education because it represents a subject area which is of Board concern. The president of the Board observed: "Math is a gate-keeper." The program has also helped teachers involve their students in their own learning. One active +PLUS+ teacher uses this as a criterion for good teaching, "I know I have done a good job when the kids don't need me anymore, when they are independent of [me] and are learning as much from other people." As one of the three most important outcomes of +PLUS+, a teacher cited the use of technology as a tool and his discovery of the way in which it can motivate students who have not been successful in mathematics. Another +PLUS+ teacher reported that the collaborative has helped him determine what he needed to teach his students by providing him a more realistic sense of what skills students should have when they graduate. This teacher is doing more with everyday materials, such as having students read graphs in the newspaper

and using statistics. Another teacher reports, "+PLUS+ has made me feel that you have to involve the students more so that they can feel a part of the learning process . . . I constantly try to use a different approach." These comments and the list of activities that teachers have engaged in through +PLUS+ are a testament to the impact the collaborative has had.

Conclusions

Because of the large number of teachers who have participated in +PLUS+ activities, the specific examples of how teachers have modified courses as a result of attending a +PLUS+ activity, teachers' comments, and the report of the impact of the Woodrow Wilson Institutes, it is clear that +PLUS+ has changed teachers' knowledge of mathematics and their teaching of mathematics. The experiences that participants have had as a result of +PLUS+ have led to the development of a core of at least 30, and probably more, strongly committed mathematics teachers who are assuming leadership roles beyond their own departments. In 29 departments, over half of which are in the LAUSD, teachers have worked together to achieve collaborative goals. An active group of mathematics teachers has been generated that now can reach out to a significantly larger number of teachers among the participating districts. Teachers are feeling comfortable having other teachers observe them teach and critically reflect on what they see. The potential impact of +PLUS+ exists in the number of teachers who have participated, the quality of programs that have been offered, and the strong emphasis that +PLUS+ puts on ensuring that teachers implement changes based on the activities they attend.

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